BREEDING BIOLOGY OF CLIFF SWALLOWS IN VIRGINIA

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The Cliff Swallow (*Petrochelidon pyrrhonota*) has recently extended its breeding range southeastward into the Piedmont regions of Virginia, North Carolina, South Carolina, Georgia (Tedards 1965, 1966, Scott 1966, Dopson and Peake 1967, Parnell 1967, Cohrs and Cohrs 1972), and Florida (Sykes 1976). This paper summarizes our studies of the breeding biology of one of these new populations of Cliff Swallows near the John H. Kerr Reservoir on the Roanoke River in the Piedmont of Virginia and North Carolina.

MATERIALS AND METHODS

Systematic examination of Cliff Swallow nests began on 12 June and ended on 21 August 1969. We gained access to nests by using a boat and a ladder. The nest contents were examined with a flashlight and a dental mirror.

Of the 36 bridges within the perimeter of the reservoir, only 7 had significant numbers of nesting swallows. We found 354 nests under these 7 bridges, but 84 nests were inaccessible, 90 were either always empty or partially destroyed old nests, and 39 were occupied by House Sparrows (*Passer domesticus*). Nest success data from 72 of the remaining 141 nests were used. The 69 nests excluded were either examined too infrequently or young were found on first examination of nest contents and clutch size could not be determined. The nests at 2 colonies, Goodall's Landing and Occoneechee, were examined at weekly intervals and the largest colony, Bluestone Landing, was visited twice a week. All of the 72 nests were in Virginia, on the upper reaches of the reservoir near Clarksville.

RESULTS AND DISCUSSION

Nest lining.—The lining of 119 active Cliff Swallow nests was recorded. Of these, 102 were lined solely with straw, 4 with straw and chicken feathers, 5 with straw and Cliff Swallow feathers, 4 with straw and unidentified feathers, 1 with straw and a material resembling cigarette filters, 1 with hair, and 2 had no lining at all. Nests have been found lined with straw, wool, and feathers (Davie 1898); grass and feathers (Forbush and May 1939); grass stems, feathers, and other materials (Bent 1942); straw or hay (Samuel 1971); and fine grasses with occasionally a few sticks, hairs, and feathers, but with many nests nearly devoid of any material (Emlen 1954).

Clutch size.—The mean clutch size of 60 nests that had only one brood for the nesting season was 3.32 ± 0.72 (Table 1) (range 2 to 5 eggs). Twelve nests had 2 complete broods. We were unable to determine the clutch size of the first brood in these, but the mean clutch size of the second brood was 3.00 ± 0.85 (Table 1), also with a range of 2 to 5 eggs. Mayhew (1958) felt that 3 to 4 eggs per clutch was the normal condition in California and Erskine

TABLE 1
NESTING SUCCESS OF CLIFF SWALLOWS AT KERR RESERVOIR, VIRGINIA

	Eggs				Young		% Total Nesting Success
Clutch Size	No. Of Clutches	No. Laid	No. Hatched	% Hatched	No. Fledged	% Fledged	
First Clutches							
2	6	12	11	91.7	11	100.0	91.7
3	32	96	79	82.3	74	93.7	77.1
4	19	76	61	80.3	51	83.6	67.1
5	3	15	11	73.3	9	81.8	60.0
Total	60	199	162		145		
Mean		3.32	2.70	81.4	2.42	89.5	72.9
S.D.		0.72	0.99		1.04		
Second Clutches							
2	3	6	4	66.7	4	100.0	66.7
3	7	21	15	71.4	15	100.0	71.4
4	1	4	3	75.0	3	100.0	75.0
5	1	5	5	100.0	4	80.0	80.0
Total	12	36	27		26		
Mean		3.00	2.25	75.0	2.17	96.3	72.2
S.D.		0.85	1.20		1.04		

and Teeple (1970) reported a mean clutch size of 3.74 in New Brunswick. Myres (1957) found the mean clutch size to range from 3.6 to 3.9 eggs (54 nests) in a British Columbia colony and Samuel (1971) found an average first clutch of 3.31 eggs (35 nests) and an average second clutch of 2.89 eggs (9 nests) in West Virginia.

Incubation period.—The length of time from the laying of the last egg to the hatching of the last young averaged 13.5 days (20 nests) in this study, ranging from 11 days (1 nest) to 16 days (2 nests). Using this same measure, Mayhew (1958) found the incubation period to be 16 days (2 nests) in California and Samuel (1971) found 15 days (7 nests) to be the mean in West Virginia. Myres (1957) took the incubation period to be 14 days, but stated 13 days may be more accurate and Burns (1915) gives 12–14 days. Cliff Swallows begin incubation the day before the last egg is laid (Mayhew 1958, Samuel 1971).

Brood size and egg mortality.—The mean brood size (number of eggs hatched per nest) was 2.70 ± 0.99 (Table 1) in the 60 first broods. Thirty-seven of 199 (18.6%) first-clutch eggs failed and there were 2 nest failures (no eggs hatched) in this sample. In the 12 nests with second broods, the

mean brood size was 2.25 ± 1.20 (Table 1). Nine of 36 (25.0%) second-clutch eggs failed to hatch and there was only one nest failure in this group. Hatching failure may be due to infertility. Samuel (1971) found that 35.2% of all Cliff Swallow eggs laid (first and second broods) did not hatch.

Nestling period.—Samuel (1971) found that the period of time between hatching and leaving the nest averaged 23.6 days in 6 broods. Mayhew (1958) found first-flying young 23 days after hatching and Burns (1921) found young left the nest 16 to 24 days after hatching. One young made its first flight at 22 days at Kerr Reservoir. Cliff Swallows often remained in the nest several days after they were able to fly, making an exact determination of the duration of the nestling period difficult to compute.

Nestling mortality and total mortality.—The mean number of young fledged per nest was 2.42 ± 1.04 (Table 1) with a nestling mortality of 10.5% in the first broods. The total first-brood nesting mortality was 27.1%. Second clutches fledged 2.17 ± 1.04 young (Table 1) for a 3.7% nestling loss and a total nesting mortality of 27.8%.

More eggs hatched, more young fledged, and there was an overall higher nesting success in first-brood nests with smaller clutches (Table 1). Although the sample size was small, nesting success in second broods tended to increase with larger clutches. However, by multiplying percent total nesting success against clutch size it can be seen that the larger clutches produced more young despite a lower percent of fledging and hatching success in first broods. Greater success with larger clutches in second broods versus those of first broods was possibly correlated with insect abundance, but quantitative measurements were not made. Both weather and the experience or skill of the adults might have been better during second broods.

Samuel (1971) found a total nesting mortality (both clutches combined) of 41.5% in West Virginia, while the nesting mortality for all clutches at Kerr Reservoir was 27.2%. In Samuel's (1969) study, the high mortality was attributed to nest abandonment caused by barn alterations, House Sparrow interactions, fallen nests, and unknown reasons. We noted little influence of House Sparrows on the reproductive success of Cliff Swallows except under bridges with small numbers of swallows. No nests fell down during our study at Kerr Reservoir. Swallows nesting under bridges were obviously not subjected to the same set of losses incurred by those nesting inside of barns. Samuel (1969, 1971) believed that the unknown-reasons group may have included abandonment by birds joining migrating flocks. Foster (1968) also reported instances of Cliff Swallows departing as a colony and leaving eggs and nestlings behind in the nests. Five nests (3 with eggs and 2 with young) were abandoned for unknown reasons at Kerr Reservoir. The different colony

sites involved and the asynchronous timing precluded the departing-as-a-colony phenomenon reported by Foster (1968) and Samuel (1969, 1971). Stewart (1972) reported heavy nestling losses in Cliff and Tree swallows (*Iridoprocne bicolor*) when adults abandoned young as a result of 24 hours or more of continuous rain. Although most birds had departed by 31 July, adults with young generally remained at these Virginia colonies until the last young left the nest (21 August).

Second broods.—Cliff Swallows typically raise one brood, although 2 broods have been suggested by Bent (1942) and McCann (1936). Samuel (1971) studied 9 pairs that raised 2 broods in West Virginia. The 12 second broods at Kerr Reservoir were all found in nests that had contained first broods earlier in the nesting season. It seems that 2 broods could occur commonly under optimum conditions at Kerr Reservoir. Grinnell (1937) found that 48 days elapsed between the day of first arrival and first-flying young and Samuel (1971) found this period to range from 38 to 48 days. Swallows were first noted on 12 April 1969 (our first visit; they probably arrived a few days earlier) and the last young left the nest on 21 August 1969. Thus, 132 days is more than ample time to accommodate 2 broods, but only 16.7% of the swallows completed 2 broods in 1969. Cliff Swallows arrive at nesting sites in successive waves of migrants (Mayhew 1958) and it seems probable that favorable spring weather could initiate early synchronous first clutches and thereby facilitate the completion of second broods.

SUMMARY

We studied the breeding biology of the Cliff Swallow in Virginia where it has recently become established as a new breeding bird. Data are presented on nest lining, clutch size, incubation period, hatching success, brood size, egg mortality, nestling period and mortality, and second broods. Little difference in breeding biology was found between the Virginia colonies and those in the remainder of their range.

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